

RemarksApplication Status and Disposition of Claims

This Amendment responds to the Office Action mailed October 29, 2009. In the Action, the Office considered claims 1-7, 9, and 10. Claim 8 has previously been canceled.

With this Amendment, Applicants amend claims 1-7, 9, and 10. These amendments find support in the specification and the previously filed claims, e.g., on page 5, lines 21-29; line 16, line 11; page 18, line 29; and page 19, lines 1-22.

Applicants note that the term “particle(s)” recited in the instant claims is a more accurate translation of the corresponding Japanese term that was used in the originally filed PCT application (of which the present application is a National Stage) than the term “bead(s)” recited in the claims.

The amendments to the specification, abstract and claims correct the grammatical/clerical errors and replace the term “bead(s)” with the term “particle(s).” As noted above, the latter term is a more accurate translation of the corresponding Japanese term that is present in the originally filed PCT application than the former term. Accordingly, pursuant to 37 C.F.R. 1.125(b), the substitute specification submitted herewith (clean and marked-up copy) includes no new matter.

No new matter has been added.

Claim Rejections Under 35 U.S.C. § 103

The Action rejects claims 1, 3-4, 7, 9, and 10 under 35 U.S.C. § 103 as allegedly being unpatentable over Kesling et al. (U.S. Patent No. 4,599,366) in view of Okubo et al. (U.S. Patent Application No. 2001/0034390). The Action also rejects claim 2 under 35 U.S.C. § 103 as allegedly unpatentable over Kesling et al. in view of Okubo et al., in further view of Harper

(Modern Plastics Handbook). The Action further rejects claims 5 and 6 under 35 U.S.C. § 103 as allegedly being unpatentable over Kesling et al. in view of Okubo et al., in further view of Henn et al. (U.S. Patent No. 5,563,178).

Applicants submit that the Action fails to establish a *prima facie* case of obviousness. In particular, Applicants submit that none of Kesling et al., Okubo et al., Harper, or Henn et al. teaches or suggests all the features of the present invention. In particular, Kesling et al. teaches that butadiene, alkyl methacrylates, alkyl acrylates, acrylonitrile, and maleic anhydride are monomers that copolymerize with styrene. (See column 2, lines 41-47). Kesling et al. also teaches impregnating the styrene polymer particles with a suitable blowing agent. (See column 2, lines 62-65). Kesling et al. also teaches incorporating the blowing agent into the particles by suspending the particles in water in a ratio between 0.3 to 1 and 1.5 to 1 (polymer to water) with the aid of suspending agent systems such as tricalcium phosphate in combination with a surfactant to promote wetting. (See column 2, lines 66-68 and column 3, lines 1-4). Kesling et al. further teaches impregnation of the particles at a temperature of 80° to 150° C. (See column 3, lines 11-14). However, Kesling et al. fails to teach impregnation at a temperature of 10° to 30° C, an internal pressure for impregnation, or a styrene-modified olefin-based resin particles comprise a polyolefin-based resin and a polystyrene-based resin, the polyolefin-based resin being selected from a low-density polyethylene, a medium-density polyethylene, a high-density polyethylene, a linear low-density polyethylene, an ethylene-vinyl acetate copolymer, a polypropylene, a propylene-ethylene copolymer and a propylene-1-butene copolymer. Applicants note that the expandable resin particles of the present invention are excellent in elasticity, oil resistance, and impact resistance.

Applicants note that there are different types of pressure measurements which are calculated differently. For example, there is atmospheric pressure, absolute pressure, gauge pressure, differential pressure, etc., all of which are calculated differently and are not equivalent in a 1 to 1 ratio. The specification utilizes, at least, two types of pressure, “internal pressure” and “gauge pressure,” when describing the present invention. “Internal pressure” and “gauge pressure” are measured pressures disclosed in several parts of the specification and denote different types of pressure. In particular, gauge pressure (recited in claims 5 and 6, and disclosed on, for example, page, 12, lines 19-22 of the specification), relates to water steam pressure during the impregnation step. Internal pressure (recited in claim 1, and disclosed on, for example, page 16, lines 10-12 of the specification) relates to the measured pressure in the V-type blender during the impregnation step.

Applicants note that measured pressures, such as “internal pressure” and “gauge pressure,” are not equivalent to atmospheric pressure or even absolute pressure. For example, “gauge pressure” is zero when referenced against ambient air pressure, and is equal to absolute pressure minus atmospheric pressure. Further, absolute pressure is zero when referenced against a perfect vacuum, and is equal to a gauged pressure plus atmospheric pressure. Applicants note that the use of these measured pressure terms, i.e., “gauge pressure” and “internal pressure,” in the specification is consistent with how the terms are used in the art. For example, see http://en.wikipedia.org/wiki/Gauge_pressure#Zero_reference and WO 99/08876. WO 99/08876 teaches that “gauge pressure relates to measured pressure relative to atmospheric pressure.” (See WO 99/08876, page 1, line 9 and page 2, lines 23-25). Therefore, Applicants submit that internal and gauged pressures are not equivalent to atmospheric pressure or absolute pressure. Applicants further submit that one of ordinary skill in the art, at the time of the present invention,

would know that an internal pressure and gauge pressure are measured pressures which are measured relative to atmospheric pressure and are not equal to atmospheric pressure and absolute pressure.

Applicants note that Kesling et al. is completely silent with respect to pressure during the impregnation step. The claims of the present invention recite an internal pressure of 0.05 to 0.30 MPa which corresponds to an absolute pressure of 0.15 to 0.40 MPa. The Action alleges that it would be obvious to one of ordinary skill in the art to use a standard temperature of 20°C and a standard pressure of 1 atmosphere (or 0.1 MPa (absolute pressure)). (Office Action, page 3, lines 13-17). Assuming that the Action's rationale is correct, at best, Kesling et al. teaches a standard pressure of 1 atmosphere (or 0.1 MPa (absolute pressure)). In teaching a standard pressure of 1 atmosphere during the impregnation step, Kesling et al. still fails to teach or suggest an internal pressure of 0.05 to 0.30 MPa (or an absolute pressure of 0.15 to 0.40 MPa) or the gauge pressure of 0.01 to 0.10 MPa.

Furthermore, contrary to the Action's assertions, Kesling et al. teaches an impregnation at temperatures ranging from 80° to 150°C (see column 3, lines 11-13) and fails to teach an impregnation temperature of 10-30°C. Therefore, Applicants submit that Kesling et al. fails to teach or suggest all the features of the present invention.

Applicants further submit that Okubo et al. fails to remedy any of the deficiencies of Kesling et al. In particular, Okubo et al. teaches liquid molding materials that include resins such as polyurethanes, epoxy resins, phenolic resins, polyesters, urea resins, olefinic resins such as polyethylene and polypropylene, and styrenic resins; rubbers such as natural rubbers, isoprene rubbers, chloroprene rubbers, styrene-butadiene rubbers, butadiene rubbers, acrylonitrile-butadiene rubbers, ethylene-propylene rubbers, butyl rubbers and acrylic rubbers. (See page 4,

paragraph [0071]). Okubo et al. also teaches that when the olefinic resins and the styrene resins are used, there can be employed a process comprising prefoaming a resin and foaming the pre-foamed resin particles, or a process comprising impregnating a blowing agent into a resin, and thereafter foaming the resin in a mold. (See page 4, paragraph [0072]). However, Okubo et al. fails to teach impregnation at a temperature of 10° to 30° C, impregnation at an internal pressure of 0.05 to 0.30 MPa (or a gauge pressure of 0.01 to 0.10 MPa or (0.05 to 0.15 MPa)), and styrene-modified olefin-based resin particles comprise a polyolefin-based resin and a polystyrene-based resin, the polyolefin-based resin being selected from a low-density polyethylene, a medium-density polyethylene, a high-density polyethylene, a linear low-density polyethylene, an ethylene-vinyl acetate copolymer, a polypropylene, a propylene-ethylene copolymer and a propylene-1-butene copolymer.

Henn et al. and Harper fail to remedy the deficiencies of Kesling et al. and Okubo et al. For example, Henn et al. teaches an expandable styrene polymer with high heat resistance and contains styrene-methacrylamide copolymers. (See column 1, lines 7-12). Henn et al. also teaches that in order to produce moldings, prefoamed beads had uniformly distributed through-holes where steam passed from 107° to 130° C. (See column 6, lines 1-9). Henn et al. also teaches treating bead polymers with steam under atmospheric pressure for a defined time. (See column 5, lines 60-61). However, Henn et al. fails to teach impregnation at a temperature of 10° to 30° C, impregnation at an internal pressure of 0.05 to 0.30 MPa (or a gauge pressure of 0.01 to 0.10 MPa or (0.05 to 0.15 MPa)), and styrene-modified olefin-based resin particles comprise a polyolefin-based resin and a polystyrene-based resin, the polyolefin-based resin being selected from a low-density polyethylene, a medium-density polyethylene, a high-density polyethylene, a linear low-density polyethylene, an ethylene-vinyl acetate copolymer, a polypropylene, a

propylene-ethylene copolymer and a propylene-1-butene copolymer. Applicants note that the Action relies on Henn et al. to teach the elements of claim 5 and 6, i.e., the water steam pressures of 0.01 to 0.10 MPa and 0.05 to 0.15 MPa. However, Henn et al. only teaches that the water steam pressure is atmospheric pressure and does not teach gauge pressure.

Harper fails to teach impregnation at a temperature of 10° to 30° C, impregnation at an internal pressure of 0.05 to 0.30 MPa (or a gauge pressure of 0.01 to 0.10 MPa or (0.05 to 0.15 MPa)), and styrene-modified olefin-based resin particles comprise a polyolefin-based resin and a polystyrene-based resin, the polyolefin-based resin being selected from a low-density polyethylene, a medium-density polyethylene, a high-density polyethylene, a linear low-density polyethylene, an ethylene-vinyl acetate copolymer, a polypropylene, a propylene-ethylene copolymer and a propylene-1-butene copolymer. Harper is relied on by the Action to teach using an aqueous or organic solvent for the application of quaternary ammonium salt antistatic agents. (See Harper, page 4.13). Applicants, therefore, submit that the Action fails to establish a *prima facie* case of obviousness as the cited references, alone or in combination, fail to teach or suggest all the elements of the present invention.

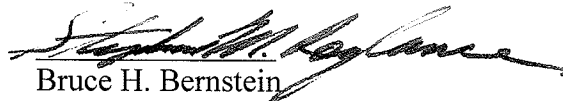
In view of the foregoing, Applicants submit that the Action has failed to establish a *prima facie* case of obviousness. Therefore, Applicants respectfully request that the 35 U.S.C. § 103 rejections be withdrawn.

CONCLUSION

In view of the foregoing remarks and amendments, Applicants respectfully request withdrawal of the rejections of record and allowance of the claims.

If the Examiner has any questions or wishes to discuss this application further, the Examiner is invited to telephone the undersigned at the below-listed telephone number.

Respectfully Submitted,
Narihiko TOGOU


Bruce H. Bernstein
Reg. No. 29,027

Stephen M. Roylance
Reg. No. 31,296

April 28, 2010
GREENBLUM & BERNSTEIN, P.L.C.
1950 Roland Clarke Place
Reston, VA 20191
(703) 716-1191

DESCRIPTION

EXPANDABLE STYRENE-MODIFIED OLEFIN-BASED RESIN BEADS
PARTICLES, PRE-EXPANDED BEADS- PARTICLES AND METHOD FOR
5 PRODUCING EXPANDED MOLDED ARTICLE

Technical Field

The present invention relates to expandable styrene-modified
olefin-based resin beads- particles, pre-expanded beads- particles and a
10 method for producing an expanded molded article.

Background Art

An expanded molded article of styrene-modified olefin-based
resin beads has been widely utilized as a goods-delivery box of
15 mechanical parts such as an automobile part and the like, or a
buffering packaging material of an electric product and the like, due to
its excellent impact resistance, wear resistance and oil resistance.

However, since a styrene-modified olefin-based resin has high
electric insulating property, the resin is easily electrified by friction, and
20 appearance of an expanded molded article is deteriorated by dust
attachment. In addition, since pollution or electrostatic breakage due
to dust collection is caused in a content, there is a problem for using a
packaging material of an electronic part as a liquid crystal display.

For the purpose of electrification prevention, there are known a
25 method of covering surfaces of resin beads with an antistatic agent, and
impregnating them with a blowing agent (Japanese Unexamined Patent
Publication No. SHO 63(1988)-125537), a method of covering surfaces
of expandable styrene-based resin beads with a particular antistatic
agent (Japanese Examined Patent Publication No. SHO 59(1984)-

35923), a method of covering surfaces of molding pre-expanded beads with an antistatic agent, and obtaining a molded article (Japanese Unexamined Patent Publication No. SHO 58(1983)-176227), and a method of modifying an olefin-based resin with a particular hydrophilic monomer, and making a surfactant contained therein (Japanese
5 Unexamined Patent Publication No. HEI 10(1998)-147660).

However, in the aforementioned method of covering surfaces of resin beads with the antistatic agent, and impregnating them with the blowing agent as disclosed in Japanese Unexamined Patent Publication
10 No. SHO 63(1988)-125537, there is a problem that a dispersion system of the blowing agent at impregnation becomes unstable, so that binding of resin particles is easily caused.

In addition, in the aforementioned method of covering surfaces of expandable styrene-based resin beads with the particular antistatic agent as disclosed in Japanese Examined Patent Publication No. SHO
15 59(1984)-35923, there are problems that an addition amount of the antistatic agent for exerting antistatic property is increased, flowability of pre-expanded beads after completion of pre-expansion is deteriorated, and filling into an interior of a mold becomes insufficient
20 at formation of an expanded article.

Further, in the aforementioned method of covering surfaces of molding pre-expanded beads with the antistatic agent, and obtaining the molded article as disclosed in Japanese Unexamined Patent Publication No. SHO 58(1983)-176227, there is a problem that the
25 number of steps in a molding maker is increased.

Furthermore, in the aforementioned method of modifying the olefin-based resin with the particular hydrophilic monomer, and making the surfactant contained therein as disclosed in Japanese Unexamined Patent Publication No. HEI 10(1998)-147660, an expanded molded

article which is excellent in antistatic property, and immediately exhibits electrostatic effect even by cracking, breakage or water washing can be obtained; however, there is a problem that since a polymerization rate of the hydrophilic monomer is worse and the
5 monomer is expensive, a cost is increased.

Disclosure of the Invention

In order to solve these problems, the present inventors continued to study and, as a result, found out that, by impregnating styrene-
10 modified olefin-based resin ~~beads~~ particles with an easily volatile blowing agent, and impregnating them with a surfactant by mixing under pressure, expandable resin ~~beads~~ particles excellent in antistatic property can be obtained, which resulted in the present invention.

Thus, according to the present invention, there is provided a
15 method for producing expandable styrene-modified olefin-based resin ~~beads~~ particles comprising steps of :

impregnating styrene-modified olefin-based resin ~~beads~~ particles
with an easily volatile blowing agent to obtain expandable resin ~~beads~~ particles, and
20 impregnating 100 parts by weight of the expandable resin ~~beads~~ particles with 0.1 to 2.0 parts by weight of a surfactant at a temperature of 10 to 30°C and a pressure of 0.05 to 0.30 MPa, to obtain expandable styrene-modified olefin-based resin ~~beads~~ particles.

According to the present invention, there is also provided a
25 method for producing pre-expanded ~~beads~~ particles comprising step of :
pre-expanding the expandable styrene-modified olefin-based resin ~~beads~~ particles obtained by the aforementioned method by heating with water steam at a gauge pressure of 0.01 to 0.10 MPa, to obtain pre-expanded ~~beads~~ particles.

According to the present invention, there is also provided a method for producing expanded molded ~~beads~~-particles comprising step of :

expanding-molding the pre-expanded ~~beads~~-particles obtained by
5 the aforementioned method by heating with water steam at a gauge pressure of 0.05 to 0.15 MPa, to obtain an expanded molded article.

Brief Description of the Drawing

Fig. 1 is a schematic diagram of an apparatus for producing
10 expandable resin ~~beads~~-particles according to Examples and Comparative Examples.

Best Mode for Carrying out the Invention

The present invention has a feature in that expandable resin
15 ~~beads~~-particles impregnated with an easily volatile blowing agent are impregnated with a surfactant under pressure.

Since the surfactant can be present at a high concentration near surfaces of the expandable resin ~~beads~~-particles by this process, excellent antistatic effect can be given to the expandable resin ~~beads~~
20 particles.

Further, since the surfactant is adhered firmly to the expandable resin ~~beads~~-particles by collision among those ~~beads~~-particles at mixing and, further, a part of the surfactant is permeated into interiors of the resin ~~beads~~-particles, the antistatic effect can be maintained even when
25 the resin ~~beads~~-particles are washed with water.

In addition, even when the resin ~~beads~~-particles are expansion-molded, since the surfactant is present in an interior of a molded article, a cross-section of the molded article also can exert antistatic effect. Herein, the case where expandable resin ~~beads~~-particles, pre-

expanded ~~beads~~-particles and a molded article have a surface specific resistance (antistatic level) of $1 \times 10^{12} \Omega$ or less is determined that they have antistatic property.

In addition, when the easily volatile blowing agent is
5 impregnated after the surfactant and the expandable resin ~~beads~~
particles are mixed, the surfactant is absorbed in the interiors of the
expandable resin ~~beads~~-particles and an amount of the surfactant
present on the surfaces of the expandable resin ~~beads~~-particles is
decreased. Therefore, the surfactant at an amount exceeding 3 parts by
10 weight relative to 100 parts by weight of the expandable resin ~~beads~~
particles is necessary in order to realize the aforementioned antistatic
level.

Like this, when a large amount of the surfactant is used, the
surfactant is foamed at removal of the expandable resin ~~beads~~-particles
15 thereby the ~~beads~~-particles is sticky. Therefore, it becomes difficult to
take out those ~~beads~~-particles, and this adversely influences on
moldability in some cases. For this reason, productivity is reduced in
some cases.

Hereinafter, the present invention will be described in more
20 detail.

Styrene-modified olefin-based resin ~~beads~~-particles used in the
present invention mean resin ~~beads~~-particles obtained by modifying a
polyolefin-based resin with a polystyrene-based resin. Herein,
modification means simple impregnation of polyolefin-based resin ~~beads~~
25 particles with a styrene-based monomer and polymerization of this,
impregnation of polyolefin-based resin ~~beads~~-particles with a styrene-
based monomer and graft polymerization of this, and both of them.

Examples of the polystyrene-based resin include resins derived
from a monomer, such as styrene, α -methylstyrene, vinyltoluene and

chlorostyrene.

Examples of the polyolefin-based resin include polyethylene-based resins such as low-density polyethylene, medium-density polyethylene, high-density polyethylene, linear low-density
5 polyethylene, ethylene-vinyl acetate copolymer and ethylene-methyl methacrylate copolymer; polypropylene-based resins such as polypropylene, propylene-ethylene copolymer and propylene-1-butene-copolymer; and resins obtained by crosslinking these polymers. Among these polyolefin-based resins, the polyethylene-based resin is
10 preferable.

In addition, other resins may be used jointly in such a range that the object and the effect of the present invention are not inhibited.

An amount of the polystyrene-based resin is preferably in a ratio of 25 to 500 parts by weight, more preferably 50 to 400 parts by weight,
15 further preferably 100 to 250 parts by weight relative to 100 parts by weight of the polyolefin-based resin. The amount less than 25 parts by weight is not preferable, since a property that rigidity of a polystyrene-based resin component is better is exhibited with difficulty. In addition, since retainability of the easily volatile blowing agent becomes extremely
20 worse, it is difficult to decrease a density, and expansion moldability becomes deficient, being not preferable. The amount of more than 500 parts by weight is not preferable, since a property that elasticity of a polyolefin-based resin component is high and oil resistance and impact resistance are better is exhibited with difficulty. In this case, since
25 styrene is not sufficiently absorbed into an interior of the polyolefin-based resin component and styrene alone is polymerized, a large amount of a polymerizable powder is generated in some cases, being not preferable.

Styrene-modified polyolefin-based resin ~~beads~~ particles are

obtained by adding a styrene-based monomer to an aqueous medium in which polyolefin-based resin ~~beads~~-particles are dispersed and retained, and polymerizing this, as described in, for example, Japanese Examined Patent Publication No. SHO 51(1976)-46138, Japanese Examined

- 5 Patent Publication No. SHO 59(1984)-3487 and Japanese Examined Patent Publication No. SHO 63(1988)-28443.

Hereinafter, the present invention will be described more specifically.

- 10 First, in the polyolefin-based resin ~~beads~~-particles, the shape thereof is not particularly limited. However, considering a filling property into a mold, a cylindrical or approximately spherical shape is preferable. In particular, an average particle diameter of the polyolefin-based resin ~~beads~~-particles is preferably 0.2 to 1.5 mm. The average particle diameter of less than 0.2 mm is not preferable, since
- 15 retainability of the blowing agent is reduced; therefore, it becomes difficult to realize a low density. In contrast, the average particle diameter of more than 1.5 mm is not preferable, since not only filling property is deteriorated, but also thinning of the molded article becomes difficult.

- 20 Modification of the polyolefin-based resin ~~beads~~-particles is performed in an aqueous suspension. Examples of an aqueous medium constituting the aqueous suspension include water, and a mixed medium of water and a water-soluble solvent (e.g., lower alcohol). In the case of this mixed medium, a medium obtained by mixing about
- 25 50% by weight of a water-soluble solvent into water may be used.

For dispersing and retaining the polyolefin-based resin ~~beads~~ particles in the aqueous medium, a dispersant can be used. The dispersant is not particularly limited, but any of the known dispersants can be used. Specific examples thereof include hardly soluble inorganic

substances such as calcium phosphate, magnesium pyrophosphate and magnesium oxide.

By impregnating the polyolefin-based resin ~~beads~~ particles in the aqueous suspension with the styrene-based monomer and polymerizing this, the polyolefin-based resin ~~beads~~ particles are modified. A polymerization initiator can be used for polymerization of the styrene-based monomer. As the polymerization initiator, polymerization initiators which are generally used as a suspension polymerization initiator for the styrene-based monomer can be used.

That is, the styrene-based monomer in which the polymerization initiator is dissolved is gradually added to the aqueous suspension of the polyolefin-based resin ~~beads~~ particles, and polymerization is performed at 80 to 100°C for 3 to 5 hours. It is more preferable that remaining styrene-based monomer is reduced and shrinkage of an expanded molded article is suppressed by raising a temperature to 130 to 140°C after the polymerization and retaining the temperature for 1 to 3 hours.

Examples of these include organic peroxides such as benzoyl peroxide, t-butyl peroxide, t-butyl peroxybenzoate, dicumyl peroxide, 2,5-dimethyl-2,5-di-t-butyl peroxyhexane, t-butylperoxy-3,5,5-trimethyl hexanoate and t-butyl-peroxy-2-ethylhexyl carbonate. These polymerization initiators may be used alone, or two or more may be used jointly.

An amount of the polymerization initiator to be used is preferably 0.1 to 0.9 parts by weight relative to 100 parts by weight of the styrene-based monomer. The amount of less than 0.1 parts by weight is not preferable, since polymerization of a styrene-based monomer easily becomes insufficient, and a large amount of the styrene-based monomer remains in the polyolefin-based resin ~~beads~~

particles, therefore shrinkage at molding easily occurs. Use of the polymerization initiator at an amount exceeding 0.9 parts by weight may reduce a molecular weight of a polystyrene-based resin. In order to obtain better physical property, a molecular weight of a styrene-
5 based resin is preferably about 200,000 to 400,000. If the amount exceeds 0.9 part by weight, only a molecular weight lower than that molecular weight is obtained in many cases.

Finally, by impregnating styrene-modified polyolefin-based resin ~~beads~~-particles during polymerization or after completion of
10 polymerization with an easily volatile blowing agent, expandable resin ~~beads~~-particles can be obtained.

As the easily volatile blowing agent, hydrocarbons such as propane, butane, isobutene, pentane, isopentane, cyclopentane and hexane, or fluorinated hydrocarbons such as HCFC-142b, HFC-134a,
15 and HCFC-123 can be used alone or by mixing two or more of them. An amount of the blowing agent to be used is determined by an intended expansion factor of a molded article, and 10 to 30 parts by weight relative to 100 parts by weight of styrene-modified polyolefin-based resin ~~beads~~-particles is preferable.

20 Further, in order to easily perform expansion and molding of expandable styrene-modified polyolefin-based resin ~~beads~~-particles, a co-blowing agent such as toluene, cyclohexane or ethylbenzene can be used. The co-blowing agent is preferably 2% by weight or less relative to 100 parts by weight of the styrene-modified polyolefin-based resin
25 ~~beads~~-particles.

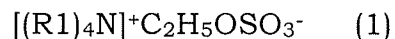
By mixing the expandable resin ~~beads~~-particles obtained as described above with a surfactant under pressure, the expandable styrene-modified olefin-based resin ~~beads~~-particles of the present invention can be obtained.

Examples of the surfactant which can be used in the present invention include noionic surfactants such as polyoxyethylenealkylamine, polyethylene glycol fatty acid ester, alkyldiethanolamide, alkyldiethanolamine and polyalkylene glycol derivative; anionic surfactants such as alkyl sulfonate, alkylbenzenesulfonate and alkyl phosphate; cationic surfactants such as aliphatic alkyl quaternary ammonium salt and trialkylbenzylammonium salt; and amphoteric surfactants such as alkylbetaine and alkylimidazoliumbetaine. It is preferable to use a surfactant having a total carbon number in a range from 5 to 20; however the range of the carbon number changes depending on a kind of the surfactant.

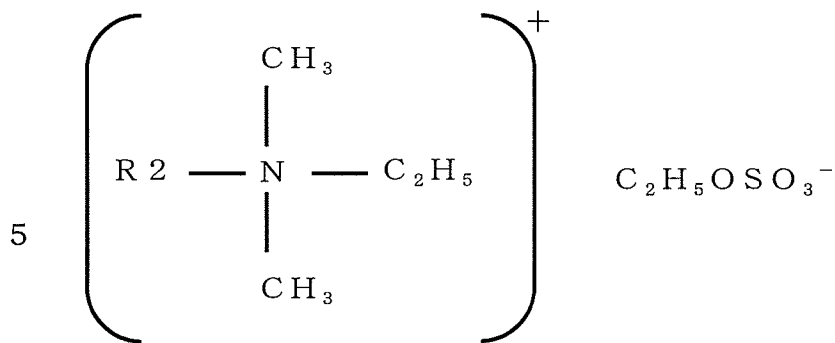
In particular, it is preferable to use a surfactant dissolved in water or an aqueous medium in that the surfactant can be uniformly adhered to surfaces of expandable resin ~~beads~~-particles in a short time. Examples of such the surfactant include the aliphatic alkyl quaternary ammonium salt, sodium alkylbenzenesulfonate and laurylbetaine. A concentration of dissolution is preferably 15 to 75% by weight. If the concentration of dissolution is less than 15% by weight, the effect of impregnating the surfaces of the expandable resin ~~beads~~-particles with an antistatic agent is deteriorated; in contrast, if the concentration exceeds 75% by weight, a viscosity is increased and it becomes difficult to uniformly adhere the surfactant to the surfaces of the expandable resin ~~beads~~-particles in a short time. Herein, the aqueous medium means water, a mixed medium of water and a water-soluble solvent (e.g., lower alcohol), or the like.

In addition, the cationic surfactant is preferable in that excellent antistatic property and flowability of expandable resin ~~beads~~-particles are not deteriorated and it does not adversely influence on filling

property at molding. In particular, the aliphatic alkyl quaternary ammonium salt is preferable. The aliphatic alkyl quaternary ammonium salt can be represented by the following general formula (1):



- 5 In the general formula (1), R1s are the same or different, and are preferably an optionally branched alkyl group of a carbon number of 1 to 17. Further, it is preferable that, among four R1s, three are an alkyl group of a carbon number of 1 to 3. In addition, among four R1s, remaining one is preferably an alkyl group of a carbon number of 5 to
- 10 20, further preferably a carbon number of 9 to 14, particularly preferably a carbon number of 12. Examples of a particularly preferable aliphatic alkyl quaternary ammonium salt include a salt of the following general formula (2):



wherein R₂ means a straight or branched alkyl group of a carbon number of 5 to 20.

It is preferable that, in the general formula (2), R₂ is a straight alkyl group. For example, CATIOGEN ESL made by Dai-ichi Kogyo Seiyaku Co., Ltd. is included in a case where R₂ is a straight alkyl group.

In addition, a surfactant which is liquid at a temperature of 10 to 30°C is preferable in that, even when not dissolved in the aqueous medium, the surfactant can be uniformly adhered to the surfaces of the expandable resin ~~beads~~-particles in a short time. Examples of such a surfactant include polyoxyethylenelaurylamine, polyoxyethylene oleyl ether and polyoxyethylene glycol monooleate.

An addition amount of the surfactant is 0.1 to 2.0 parts by weight, preferably 0.5 to 1.5 parts by weight relative to 100 parts by weight of the expandable resin ~~beads~~-particles. The amount of less than 0.1 parts by weight is not preferable, since a desired electrostatic property can not be imparted to expandable styrene-modified olefin-based resin ~~beads~~-particles, pre-expanded ~~beads~~-particles and an expanded molded article. In contrast, the amount of more than 2.0 parts by weight is not preferable, since expandable styrene-modified olefin-based ~~beads~~-particles and pre-expanded ~~beads~~-particles are sticky, therefore handling becomes difficult. Further, it becomes

difficult to fill pre-expanded ~~beads~~-particles into a molding mold, the resulting expanded molded article is sticky and, conversely, dust is easily adhered thereto, being not preferable.

Impregnation of the surfactant is performed under pressure.

- 5 Specifically, impregnation is performed under an impregnation temperature of 10 to 30°C and an impregnation pressure of 0.05 to 0.30 MPa. A more preferable impregnation temperature is 15 to 25°C and a more preferable impregnation pressure is 0.10 to 0.25 MPa.

- 10 If the impregnation temperature is less than 10°C and the impregnation pressure is less than 0.05 MPa, permeation of the surfactant into the surfaces of the expandable resin ~~beads~~-particles is worse and sufficient antistatic property is not obtained at a cross-section of an expanded molded article. In contrast, if the impregnation temperature exceeds 30°C and the impregnation pressure exceeds 0.03
15 MPa, a rate of permeating the surfactant into the expandable resin ~~beads~~-particles is high, therefore, if the amount of the surfactant is small, sufficient electrostatic property at a surface of the expanded molded article can not be obtained.

- An apparatus which can be used for mixing the expandable resin
20 ~~beads~~-particles and the surfactant is not particularly limited, but examples thereof include a hermetic-type rotary mixer.

- The expandable styrene-modified olefin-based resin ~~beads~~
particles obtained as described above can be formulated into pre-expanded ~~beads~~-particles by pre-expansion to a predetermined density
25 by the known method (e.g., heating with water steam having a gauge pressure of 0.01 to 0.10 MPa).

Further, the pre-expanded ~~beads~~-particles are filled into a mold, and this is heated to thermally fuse the pre-expanded ~~beads~~-particles by reheating, thereby, the expanded molded particle can be obtained.

As a heating medium, water steam at a gauge pressure of 0.05 to 0.15 MPa is suitably used. A density of the expanded molded article is preferably 12 to 200 kg/m³. The density of lower than 12 kg/m³ is not preferable, since a sufficient strength is not obtained; in contrast, the
5 density of higher than 200 kg/m³ is not preferable, since lightening can not be achieved.

The expanded molded article of the present invention can be used in various utilities and, particularly, can be suitably used in a goods-delivery box of a mechanical part such as an automobile part, or
10 a buffering packaging material of an electric product.

Examples

Hereinafter, the present invention will be described by way of Examples; however, the present invention is not limited thereto.

15 (Measurement of bulk factor)

A bulk factor of expanded ~~beads~~-particles was obtained by the following equation according to JIS K 6767.

$$A \text{ (times)} = (V/W) \times \rho$$

A: bulk factor

20 V: bulk volume of expanded ~~beads~~-particles (cm³)

W: weight of expanded ~~beads~~-particles (g)

ρ : density of polyolefin-based resin (g/cm³)

(Measurement of surface specific resistance)

An expanded molded article is allowed to stand in a constant
25 temperature constant humidity chamber at a temperature of 20°C and a humidity of 65% for 3 days or longer, and a surface specific resistance of each of an expanded molded article surface (a) and an expanded molded article cross-section (b) is measured. Further, the expanded molded article surface is washed with pure water at an amount of 100

ml/sec for 1 minute thorough a faucet having a diameter of 1 cm, thereafter, a moisture attached to the expanded molded article surface is removed with a towel paper, this is allowed to stand in a constant temperature constant humidity chamber at a temperature of 20°C and a
5 humidity of 65% for 3 days or longer, and a surface specific resistance of a washed expanded molded article surface (c) is measured. The surface specific resistance is measured using a super insulation meter, SM-10E, manufactured by TOA Corp. according to JIS K 6911. In all of (a), (b) and (c), if the surface specific resistance is $1 \times 10^{12} \Omega$ or less, it
10 is determined that the expanded molded article has antistatic property.
(Measurement of molecular weight)

Preparation of sample: 50 mg of styrene-modified polystyrene-based resin ~~beads~~ particles was divided into two with a cutter knife along with a central line, this is immersed in 10 ml of THF at 20°C for
15 24 hours to dissolve a styrene component in THF, and this THF solution is used as a measurement sample.

An average molecular weight (Mw) of a polymer was measured by GPC (Gel Permeation Chromatography) under the following conditions.

Measuring apparatus: High speed GPC apparatus, HLC-8020,
20 manufactured by Tosoh Corp.

Column: HSG-60S \times 2

HSG-40H \times 1

HSG-20H \times 1, manufactured by Sekisui Fine Chemicals Co., Ltd.

25 Measurement conditions: Column temperature: 40°C

Mobile phase: THF (tetrahydrofuran)

Flow rate: 1.0 ml/min

Injection amount: 500 ml

Detector: RID-6A manufactured by

Tosoh Corp.

Measurement of molecular weight of sample: Upon measurement of the molecular weight of the sample, the measurement condition was selected so that a molecular weight distribution possessed by the sample is included in such a range that a logarithm of a molecular weight of a calibration line prepared by several kinds of monodisperse polystyrene standard samples and count number are linear. In the preset invention, a calibration line for polystyrene was prepared using six polystyrene standard samples (TSK standard polystyrene), made by Tosoh Corp., having weight average molecular weights of 2.74×10^3 , 1.91×10^4 , 1.02×10^5 , 3.55×10^5 , 2.89×10^6 and 4.48×10^6 , respectively.

Example 1

45 kg of pure water, 300 g of magnesium pyrophosphate as a dispersant, and 50 g of sodium dodecylbenzenesulfonate (25% aqueous solution) were added to an autoclave having an internal volume of 100 liters to obtain an aqueous medium.

Then, vinyl acetate 5%-containing polyethylene (NOVATEC EVA LV121 made by Japan Polyethylene Corp.) was formulated into ~~beads~~ particles having an average bead diameter of 1 mm using an extruder.

12 kg of the ~~beads~~-particles was suspended in the aqueous medium, a solution in which 85 g of dicumyl peroxide, 40 g of benzoyl peroxide and 4 g of t-butylperoxide were dissolved in 23 kg of styrene was gradually added, and polymerization was performed at 90°C for 4 hours. Thereafter, a temperature was raised to 140°C, and was retained at the same temperature for 2 hours.

After cooled to a normal temperature, a content was taken out by separating from water, and a dispersant was removed by water washing to obtain styrene-modified polyethylene-based resin ~~beads~~-particles

(molecular weight: about 300,000) consisting of 100 parts by weight of polyethylene and 202 parts by weight of polystyrene.

To a V-type blender 1 shown in Fig. 1, which has an internal volume of 50 liters, is pressure resistant and can be sealed, was added
5 15 kg of the styrene-modified polyethylene-based resin ~~beads~~-particles, and this was sealed and stirred. Next, 2 kg of butane (volume ratio of isobutene : normal butane is 3 : 7) was weighed into a pressure-resistance container 2 connected to the V-type blender 1, and pressed therein by nitrogen pressure. Then, an internal temperature of the V-
10 type blender was maintained at 70°C for 4 hours, and was cooled to 15°C. Thereafter, 150 g of an aqueous solution of an aliphatic alkyl quaternary ammonium salt (CATIOGEN ESL made by Dai-ichi Kogyo Seiyaku Co., Ltd.: including a salt in which, in the general formula (2), R2 is an alkyl group of $-(CH_2)_{11}CH_3$, concentration: 50%) was placed
15 into the pressure-resistant container 2, and pressed into the V-type blender 1 by nitrogen pressure. Next, stirring was performed for 30 minutes under the conditions of an internal temperature and an internal pressure of the V-type blender of 15°C and 0.17 Mpa, respectively, and the expandable resin ~~beads~~-particles were taken out.

20 In Fig. 1, 3 denotes an blowing agent retaining container, 4 denotes a surfactant charging port, 5 denotes a thermometer, 6 denotes a manometer, 7 denotes a pressure-releasing bulb, 8 denotes a bead charging and taking out port, 9 denotes a warm water or cold water inlet, 10 denotes a warm water or cold water outlet, and 11 denotes a
25 rotating direction of a stirrer of the V-type blender.

The resulting expandable resin ~~beads~~-particles were immediately placed into a batch expanding machine, pre-expanded to a bulk factor of 20 with water steam having a gauge pressure of 0.03 MPa, to obtain pre-expanded ~~beads~~-particles and, thereafter, which was stored at room

temperature for 24 hours.

Then, the pre-expanded ~~beads~~ particles were filled into a 400 × 300 × 100 mm mold of a molding machine, water steam having a gauge pressure of 0.08 MPa was injected for 60 seconds, and this was
5 expanded by heating. After cooled for 5 minutes, an expanded molded article was taken out.

A kind, amount, addition time and mixing condition of the surfactant and a surface specific resistance of the expanded molded article are shown in Table 1.

10 Example 2

According to the same manner as that of Example 1 except that an aqueous solution of an aliphatic alkyl quaternary ammonium salt was 225 g, an expanded molded article was obtained. A kind, amount, addition time and mixing condition of a surfactant and a surface
15 specific resistance of the expanded molded article are shown in Table 1.
Example 3

According to the same manner as that of Example 1 except that an aqueous solution of an aliphatic alkyl quaternary ammonium salt was 450 g, an expanded molded article was obtained. A kind, amount,
20 addition time and mixing condition of a surfactant and a surface specific resistance of the expanded molded article are shown in Table 1.
Example 4

According to the same manner as that of Example 1 except that 150 g of polyoxyethylenelaurylamine (ELEGAN S-100 made by NOF
25 Corp.) which is a yellow liquid at a normal temperature (25°C) was used in place of an aqueous solution of an aliphatic alkyl quaternary ammonium salt, an expanded molded article was obtained. A kind, amount, addition time and mixing condition of a surfactant and a surface specific resistance of the expanded molded article are shown in

Table 1.

Example 5

According to the same manner as that of Example 1 except that 600 g of sodium dodecylbenzenesulfonate (25% aqueous solution, 5 NEOPELEX F-25 made by Kao Corp.) which is a yellow transparent viscous liquid at a normal temperature (25°C) was used in place of an aqueous solution of an aliphatic alkyl quaternary ammonium salt, an expanded molded article was obtained. A kind, amount, addition time and mixing condition of a surfactant and a surface specific resistance of 10 the expanded molded article are shown in Table 1.

Example 6

According to the same manner as that of Example 1 except that 484 g of laurylbetaine (31% aqueous solution, ANHYTOL 20 BS made by Kao Corp.) which is a pale yellow liquid at a normal temperature (25°C) 15 was used in place of an aqueous solution of an aliphatic alkyl quaternary ammonium salt, an expanded molded article was obtained. A kind, amount, addition time and mixing condition of a surfactant and a surface specific resistance of the expanded molded article are shown in Table 1.

20 Example 7

According to the same manner as that of Example 1 except that an aqueous solution of an aliphatic alkyl quaternary ammonium salt was 300 g, an expanded molded article was obtained. A kind, amount, addition time and mixing condition of a surfactant and a surface 25 specific resistance of the expanded molded article are shown in Table 1.

Example 8

To the same V-type blender 1 as that of Example 1 shown in Fig. 1, which has an internal volume of 50 liters, is pressure resistant and can be sealed, was added 15 kg of the styrene-modified polyethylene-

based resin ~~beads~~-particles obtained in Example 1, the blender was sealed, and ~~beads~~-particles were stirred. Next, 2 kg of butane (ratio of isobutene : normal butane is 3 : 7) was weighed into the pressure-resistant container 2 connected to the V-type blender 1, and pressed
5 under nitrogen-pressure. An internal temperature of the V-type blender was maintained at 70°C for 4 hours, and this was cooled to 25°C. Thereafter, 300 g of an aqueous solution of an aliphatic alkyl quaternary ammonium salt (same in Example 1) was placed into the pressure-resistant container, and was pressed into the V-type blender 1
10 under nitrogen pressure. Then, stirring was performed for 30 minutes under the condition of the internal temperature and an internal pressure of the V-type blender of 25°C and 0.25 MPa, respectively, and expandable resin ~~beads~~-particles were taken out.

Next, pre-expanded ~~beads~~-particles and an expanded molded
15 article were obtained as in Example 1.

A kind, amount, addition time and mixing condition of a surfactant and a surface specific resistance of the expanded molded article are shown in Table 1.

Example 9

20 To the same V-type blender 1 as that of Example 1 shown in Fig. 1, which has an internal volume of 50 liters, is pressure-resistant and can be sealed, was added 15 kg of the styrene-modified polyethylene-based resin ~~beads~~-particles obtained in Example 1, the blender was sealed, and the ~~beads~~-particles were stirred. Next, 2 kg of butane (ratio
25 of isobutene : normal butane is 3 : 7) was weighed into the pressure resistant container 2 connected to the V-type blender 1, and pressed under nitrogen-pressure. Then, an internal temperature of the V-type blender was maintained at 70°C for 4 hours, and was cooled to 12°C. Thereafter, 300 g of an aqueous solution of an aliphatic alkyl

quaternary ammonium salt (same in Example 1) was placed into the pressure resistant container, and was pressed into the V-type blender 1 under nitrogen pressure. Next, stirring was performed for 30 minutes under the condition of the internal temperature and an internal
5 pressure of the V-type blender of 12°C and 0.10 MPa, respectively, and expandable resin ~~beads~~-particles were taken out.

Next, pre-expanded ~~beads~~-particles and an expanded molded article were obtained as in Example 1.

A kind, amount, addition time and mixing condition of a
10 surfactant and a surface specific resistance of the expanded molded article are shown in Table 1.

Example 10

53 kg of pure water, 280 g of magnesium pyrophosphate as a dispersant, and 50 g of sodium dodecylbenzenesulfonate (same as
15 Example 5) were added to an autoclave having an internal volume of 100 liters, to obtain an aqueous medium. Next, vinyl acetate 5%-containing polyethylene (NOVATEC EVA LV121 made by Japan Polyethylene Corp.) was formulated into ~~beads~~-particles having an average bead diameter of 1 mm using an extruder.

20 17 kg of the ~~beads~~-particles were suspended in the aqueous medium, a solution in which 65 g of dicumyl peroxide, 30 g of benzoyl peroxide and 3.4 g of t-butyl peroxide were dissolved in 17 kg of styrene was gradually added, and polymerization was performed at 90°C for 3 hours. Thereafter, a temperature was raised to 140°C, and was
25 retained at the same temperature for 2 hours.

After cooled to a normal temperature (25°C), a content was taken out by separating from water, and a dispersant was removed by water washing, to obtain styrene-modified polyethylene-based resin ~~beads~~ (molecular weight: about 300,000) consisting of 100 parts by weight of

polyethylene and 105 parts by weight of polystyrene.

Next, according to the same manner as that of Example 1 except that the styrene-modified polyethylene-based resin ~~beads~~particles were used, an expanded molded article was obtained.

- 5 A kind, amount, addition time and mixing condition of a surfactant and a surface specific resistance of the expanded molded article are shown in Table 1.

Example 11

40 kg of pure water, 250 g of magnesium pyrophosphate as a
10 dispersant and 60 g of sodium dodecylbenzenesulfonate (same as Example 5) were added to an autoclave having an internal volume of 100 liters, to obtain an aqueous medium. Next, polyethylene (TUF-2032 made by Nippon Unicar Co., Ltd.) was formulated into ~~beads~~particles having an average bead diameter of 1 mm using an extruder.

- 15 12 kg of the ~~beads~~particles were suspended in the aqueous medium, a solution in which 70 g of dicumyl peroxide and 2 g of t-butyl peroxide were dissolved in 28 kg of styrene was gradually added, and polymerization was performed at 100°C for 4 hours. Thereafter, a temperature was raised to 140°C, and retained at the same temperature
20 for 2 hours.

- After cooled to a normal temperature 25°C, a content was taken out by separating from water, and a dispersant was removed by water washing to obtain styrene-modified polyethylene-based resin ~~beads~~particles (molecular weight: about 350,000) consisting of 100 parts by
25 weight of polyethylene and 233 by parts by weight of polystyrene.

Next, according to the same manner as that of Example 1 except that the styrene-modified polyethylene-based resin ~~beads~~particles were used, an expanded molded article was obtained.

A kind, amount, addition time and mixing condition of a

surfactant and a surface specific resistance of the expanded molded article are shown in Table 1.

Example 12

According to the same manner as that of Example 1 except that
5 butane was changed to 1.5 kg of pentane (ratio of isopentane : normal pentane is 2 : 8), an expanded molded article was obtained.

A kind, amount, addition time and mixing condition of a surfactant and a surface specific resistance of the expanded molded article are shown in Table 1.

10 Comparative Example 1

To the same V-type blender 1 as that of Example 1, which has an internal volume of 50 liters, is pressure-resistant and can be sealed, were added 15 kg of the styrene-modified polyethylene-based resin ~~beads~~-particles and 450 g of the aqueous solution of the aliphatic alkyl
15 quaternary ammonium salt which are the same as those of Example 1, the blender was sealed, and 2 kg of butane (ratio of isobutene : normal butane is 3 : 7) was pressed while stirring. Then, an internal temperature of the V-type blender was maintained at 70°C for 4 hours, cooled to 15°C, and expandable resin ~~beads~~-particles were taken out.

20 Next, pre-expanded ~~beads~~-particles and an expanded molded article were obtained as in Example 1.

A kind, amount, addition time and mixing condition of a surfactant and a surface specific resistance of the expanded molded article are shown in Table 1.

25 Comparative Example 2

According to the same manner as that of Example 1 except that an aqueous solution of an aliphatic alkyl quaternary ammonium salt was 24 g, an expanded molded article was obtained. A kind, amount, addition time and mixing condition of a surfactant and a surface

specific resistance of the expanded molded article are shown in Table 1.

Comparative Example 3

According to the same manner as that of Example 1 except that an aqueous solution of an aliphatic alkyl quaternary ammonium salt
5 was 900 g, expandable resin ~~beads~~-particles were obtained. However, since foaming at the time when the expandable resin ~~beads~~-particles were taken out from the V-type blender was severe, and flowability of pre-expanded ~~beads~~-particles obtained therefrom was worse, filling into a molding mold became worse, and a better expanded molded article
10 could not be obtained. A kind, amount, addition time and mixing condition of a surfactant are shown in Table 1.

Comparative Example 4

To the same V-type blender 1 as that of Example 1, which has an internal volume of 50 liters, is pressure resistance and can be
15 sealed, was added 15 kg of the styrene-modified polyethylene-based resin ~~beads~~-particles as in Example 1, the blender was sealed, and the ~~beads~~-particles were stirred. Next, 2 kg of butane (ratio of isobutane : normal butane is 3 : 7) was weighed in the pressure resistant container 2 connected to the V-type blender 1, and pressed under nitrogen
20 pressure. Then, an internal temperature of the V-type blender was maintained at 70°C for 4 hours, and was cooled to 30°C. Thereafter, 150 g of an aqueous solution of an aliphatic alkyl quaternary ammonium salt (same as Example 1) was placed into a pressure resistant container and placed into the V-type blender 1 under nitrogen
25 pressure. Next, stirring was performed for 30 minutes under the condition of the internal temperature and an internal pressure of the V-type blender of 30°C and 0.35 MPa, respectively, and expandable resin ~~beads~~-particles were taken out.

Then, pre-expanded ~~beads~~-particles and an expanded molded

article were obtained as in Example 1.

A kind, amount, addition time and mixing condition of a surfactant and a surface specific resistance of the expanded molded article are shown in Table 1.

5 Comparative Example 5

To the same V-type blender 1 as that of Example 1, which has an internal volume of 50 liters, is pressure-resistant and can be sealed, was added 15 kg of the styrene-modified polyethylene-based resin ~~beads~~ particles as in Example 1, the blender was sealed, and the material was
10 stirred. Next, 2 kg of butane (ratio of isobutane : normal butane is 3 : 7) was weighed in the pressure resistant container 2 connected to the V-type blender, and pressed under nitrogen pressure. Then, an internal temperature of a V-type blender was maintained at 70°C for 4 hours, and cooled to at 35°C. Thereafter, the pressure-releasing valve 3 was
15 opened to an internal pressure of 0 MPa (atmospheric pressure). Then, 150 g of an aqueous solution of an aliphatic alkyl quaternary ammonium salt (same as Example 1) was placed in the V-type blender 1 while the pressure releasing valve 7 was opened. Next, stirring was performed for 30 minutes under the internal temperature and the
20 internal pressure of the V-type blender of 35°C and 0 MPa, respectively, and expandable resin ~~beads~~ particles were taken out.

Next, pre-expanded ~~beads~~ particles and an expanded molded article were obtained as in Example 1.

A kind, amount, addition time and mixing condition of a
25 surfactant and a surface specific resistance of the expanded molded article are shown in Table 1.

Comparative Example 6

To the same V-type blender 1 as that of Example 1, which has an internal volume of 50 liters, is pressure resistant and can be sealed,

was added 15 kg of the styrene-modified polyethylene-based resin ~~beads~~
particles as in Example 1, the blender was sealed, and the material was
stirred. Next, 2 kg of butane (ratio of isobutane : normal butane is 3 :
7) was weighed in the pressure-resistant container 2 connected to the
5 V-type blender 1, and was pressed under nitrogen pressure. Then, an
internal temperature of the V-type blender was maintained at 70°C for 4
hours, and cooled to 15°C. Thereafter, the pressure-releasing valve 7
was opened to an internal pressure of 0 MPa (atmospheric pressure).
Then, 150 g of an aqueous solution of an aliphatic alkyl quaternary
10 ammonium salt (same as Example 1) was placed into the V-type blender
1 while the pressure-releasing valve 7 was opened. Next, stirring was
performed for 30 minutes under the condition of the internal
temperature and the internal pressure of the V-type blender of 15°C
and 0 MPa, respectively, and expandable resin ~~beads~~-particles were
15 taken out.

Next, pre-expanded ~~beads~~-particles and an expanded molded
article were obtained as in Example 1.

A kind, amount, addition time and mixing condition of a
surfactant and a surface specific resistance of the expanded molded
20 article are shown in Table 1.

Comparative Example 7

To the same V-type blender 1 as that of Example 1, which has
an internal volume of 50 liters, is pressure-resistant and can be sealed,
was added 15 kg of the styrene-modified polyethylene-based resin ~~beads~~
25 particles as in Example 1, the blender was sealed, and the material was
stirred. Next, 2 kg of butane (ratio of isobutane : normal butane is 3 :
7) was weighed in the pressure-resistant container 2 connected to the
V-type blender 1, and pressed therein under nitrogen pressure. Then,
an internal temperature of the V-type blender was maintained at 70°C

for 4 hours, and cooled to 5°C. Thereafter, 150 g of an aqueous solution of an aliphatic alkyl quaternary ammonium salt (same as Example 1) was placed into the pressure-resistant container, and placed into the V-type blender 1 under nitrogen pressure. Next, stirring
5 was performed for 30 minutes under the condition of the internal temperature and an internal pressure of the V-type blender of 5°C and 0.06 MPa, respectively, and expanded resin ~~beads~~ particles were taken out.

Next, pre-expanded ~~beads~~ particles and an expanded molding
10 article were obtained as in Example 1.

A kind, amount, addition time and mixing condition of a surfactant and a surface specific resistance of the expanded molded article are shown in Table 1.

15

Table 1-1

	kind of styrene-modified polyethylene-based resin beads-particles	blowing agent		surfactant	amount (parts by weight)	addition time	mixing condition	surface specific resistance (Ω)		
		kind	amount (parts by weight)					kind	molded article surface (a)	molded article cross-section (b)
Ex 1	a	butane	13.3	aliphatic alkyl quaternary ammonium salt	0.5	after impregnating	15°C 0.17Pa	2×10^{11}	5×10^{11}	5×10^{11}
Ex 2	a	butane	13.3	aliphatic alkyl quaternary ammonium salt	0.75	after impregnating	15°C 0.17Pa	1×10^{10}	1×10^{10}	1×10^{11}
Ex 3	a	butane	13.3	aliphatic alkyl quaternary ammonium salt	1.5	after impregnating	15°C 0.17Pa	1×10^{10}	1×10^{10}	1×10^{11}
Ex 4	a	butane	13.3	polyoxyethylene/laurylamine	1.0	after impregnating	15°C 0.17Pa	1×10^{11}	3×10^{11}	4×10^{11}
Ex 5	a	butane	13.3	sodium dodecylbenzenesulfonate	1.0	after impregnating	15°C 0.17Pa	1×10^{11}	1×10^{11}	5×10^{11}
Ex 6	a	butane	13.3	laurylbetaine	1.0	after impregnating	15°C 0.17Pa	2×10^{11}	4×10^{11}	6×10^{11}
Ex 7	a	butane	13.3	aliphatic alkyl quaternary ammonium salt	1.0	after impregnating	15°C 0.17Pa	1×10^{10}	1×10^{10}	1×10^{11}
Ex 8	a	butane	13.3	aliphatic alkyl quaternary ammonium salt	1.0	after impregnating	25°C 0.23Pa	1×10^{10}	1×10^{10}	3×10^{11}
Ex 9	a	butane	13.3	aliphatic alkyl quaternary ammonium salt	1.0	after impregnating	12°C 0.10Pa	1×10^{10}	1×10^{11}	1×10^{11}
Ex 10	b	butane	13.3	aliphatic alkyl quaternary ammonium salt	0.5	after impregnating	15°C 0.17Pa	2×10^{11}	3×10^{11}	5×10^{11}

Table 1-2

	kind of styrene-modified polyethylene-based resin beads-particles	blowing agent		surfactant	amount (parts by weight)	addition time	mixing condition	surface specific resistance (Ω)			
		kind	amount (parts by weight)					kind	molded article surface (a)	molded article cross-section (b)	washed molded article surface (c)
Ex. 1-1	c	butane	13.3	aliphatic alkyl quaternary ammonium salt	0.5	after impregnating	15°C 0.17MPa	1×10 ¹¹	5×10 ¹¹	5×10 ¹¹	
Ex. 1-2	a	pentane	10.0	aliphatic alkyl quaternary ammonium salt	0.5	after impregnating	15°C 0.17MPa	1×10 ¹¹	5×10 ¹¹	5×10 ¹¹	
Com. Ex. 1	a	butane	13.3	aliphatic alkyl quaternary ammonium salt	1.5	before impregnating	—	1×10 ¹³	1×10 ¹³	1×10 ¹³	
Com. Ex. 2	a	butane	13.3	aliphatic alkyl quaternary ammonium salt	0.08	after impregnating	15°C 0.17MPa	3×10 ¹²	1×10 ¹³	3×10 ¹³	
Com. Ex. 3	a	butane	13.3	aliphatic alkyl quaternary ammonium salt	3.0	after impregnating	15°C 0.17MPa	*			
Com. Ex. 4	a	butane	13.3	aliphatic alkyl quaternary ammonium salt	0.5	after impregnating	30°C 0.33MPa	1×10 ¹³	1×10 ¹¹	3×10 ¹³	
Com. Ex. 5	a	butane	13.3	aliphatic alkyl quaternary ammonium salt	0.5	after impregnating	35°C 0MPa	1×10 ¹²	1×10 ¹¹	1×10 ¹⁴	
Com. Ex. 6	a	butane	13.3	aliphatic alkyl quaternary ammonium salt	0.5	after impregnating	15°C 0MPa	1×10 ¹⁰	1×10 ¹⁴	1×10 ¹⁴	
Com. Ex. 7	a	butane	13.3	aliphatic alkyl quaternary ammonium salt	0.5	after impregnating	5°C 0.03MPa	1×10 ¹⁰	1×10 ¹⁴	1×10 ¹⁵	

In Table 1, a, b, c, butane, pentane and * mean the following contents.

a: styrene-modified polyethylene-based resin ~~beads~~-particles
5 (molecular weight: about 300,000) consisting of 100 parts by weight of polyethylene and 202 parts by weight of polystyrene described in Example 1

b: styrene-modified polyethylene-based resin ~~beads~~-particles
(molecular weight: about 300,000) consisting of 100 parts by weight of
10 polyethylene and 105 parts by weight of polystyrene described in Example 10

c: styrene-modified polyethylene-based resin ~~beads~~-particles
(molecular weight: about 350,000) consisting of 100 parts by weight of polyethylene and 233 parts by weight of polystyrene described in
15 Example 11

Butane: volume ratio of isobutane : normal butane of 3 : 7

Pentane: volume ratio of isopentane : normal pentane of 2 : 8

*: foaming at extraction from a reactor is severe, flowability of pre-expanded ~~beads~~-particles is worse, and filling is worse; therefore,
20 molding is impossible.

From Example 1 and Comparative Examples 4 to 7, by impregnating expandable resin ~~beads~~-particles with the surfactant under the temperature and pressure condition in a range of the present invention, the expanded molded article having an excellent surface
25 specific resistance can be obtained.

From Example 3 and Comparative Example 1, by impregnating with the surfactant after impregnation with the blowing agent, the expanded molded article having an excellent surface specific resistance can be obtained.

5 From Examples 1 to 12 and Comparative Examples 2 and 3, by rendering an amount of the surfactant to be used in a range of the present invention, the expanded molded article having an excellent surface specific resistance can be obtained.

10 As described above, according to the present invention, by impregnating styrene-modified olefin-based resin ~~beads~~particles with the easily volatile blowing agent to obtain expandable resin ~~beads~~particles, and impregnating the expandable resin ~~beads~~particles with the surfactant under particular condition, expandable styrene-modified
15 olefin-based resin ~~beads~~particles excellent in antistatic property can be obtained without using resin ~~beads~~particles copolymerized with the expensive hydrophilic monomer. The method of the present invention is an easy production method, and is economical.

 In addition, in the expanded molded article obtained from the
20 expanded styrene-modified olefin-based resin ~~beads~~particles, since the surfactant is contained not only in surfaces thereof, but also in interiors thereof, antistatic property is possessed even when cracking, breakage or water-washing occurs. For this reason, the article can be used in the package material of the electronic part such as the liquid crystal
25 display.

What is claimed is:

1. A method for producing expandable styrene-modified olefin-based resin ~~beads~~particles comprising steps of :

5 impregnating styrene-modified olefin-based resin ~~beads~~particles with an easily volatile blowing agent to obtain expandable resin ~~beads~~particles, and

 impregnating 100 parts by weight of the expandable resin ~~beads~~particles with 0.1 to 2.0 parts by weight of a surfactant at a temperature of 10 to 30°C and a pressure of 0.05 to 0.30 MPa, to obtain
10 expandable styrene-modified olefin-based resin ~~beads~~particles.

2. The method for producing pre-expanded ~~beads~~particles of claim 1, wherein the surfactant is dissolved in an aqueous medium.

15 3. The method for producing pre-expanded ~~beads~~particles of claim 1, wherein the surfactant is a cationic surfactant.

4. The method for producing pre-expanded ~~beads~~particles of claim 1, wherein the surfactant is liquid at a temperature of 10 to 30°C.

20

5. A method for producing pre-expanded ~~beads~~particles comprising step of :

 pre-expanding the expandable styrene-modified olefin-based resin ~~beads~~particles obtained by the method of claim 1 by heating with
25 water steam at a gauge pressure of 0.01 to 0.10 MPa, to obtain pre-

expanded ~~beads~~ particles.

6. A method for producing expanded molded ~~beads~~ particles comprising step of :

- 5 expanding-molding the pre-expanded ~~beads~~ particles obtained by the method of claim 5 by heating with water steam at a gauge pressure of 0.05 to 0.15 MPa, to obtain an expanded molded article.